Greywater Recycling System

The subject of the invention is a greywater recycling system, primarily for the economical flushing of toilets, consisting of one or more tanks, bath tub, a washing machine provided with a primary water pump, greywater pipe, flushing conduit, flushing valve, and in the tank a floating ball.

The traditional flushing toilet constructions are described in detail on the pages 593-599 of the book "Water supply, canalization, gas supply of buildings" (written by Ballai and Marton, published by Műszaki Könyvkiadó, Budapest, 1977). The traditional overfeed flushing toilet consists of an open tank with a capacity of about 8 litre, a float valve, and a weighted flushing valve. The pivoted support arm of the float valve closes directly the fill valve, the upper part of the floater is floating on the surface of the water. The disadvantage of those flushing constructions is that they use potable water, which is becoming more and more valuable and expensive. As freshwater reserves of the Earth have become less available, the need to reuse part of the domestic waste-water has arisen. The waste-water produced by washing machines, bath tub and shower is called grey-water.

There are a number of known grey-water reusing equipments. The technical solution as per the US 5,201,082 patent script is grey-water for flushing toilet. It does not use clean water, so the use of greywater and clean water is not combined, and no mention is made about enlarging the tank.

The technical solution as per the US 5,406,657 patent script, uses the standard flushing tank, and in addition to it a greywater collecting tank is used from which the grey-water is pumped into the flushing tank if the water level does not reach the maximum level in it. It does not use clean water, so the use of greywater and clean water is not combined, and no mention is made about enlarging the tank.

According to the US 5,406,657 patent script a tube connected to the sink-hole of the wash basin conducts the greywater to the traditional sized flushing tank, which is

located directly above the toilet bowl. The sink-hole of the wash basin (or shower, etc.) must be at a level higher than the inlet hole of the tank—which can include the dwelling floor level difference, so that the greywater could flow into the tank by gravity free-fall. The clean water fill valve is omitted from the tank, consequently, if there is no sufficient quantity of greywater — which can be seen through a sight glass — the tank can be filled up by opening the tap of the wash basin. Thus filling the tank is not automatic.

The US 4,017,395 uses a separate tank-system for treating greywater, including solid-liquid separator tank, disinfecting tank, etc. The size of the flushing tank is not enlarged, and flushing is not combined with clean water.

The technical solution as per the description of the US 4,115,876 is using a separate holding tank from where the raw waste water is pumped into a combined sterilization and flocculation cell unit, then it is pumped into another tank, and only after that is it pumped into the flushing tank. The system is conceived for toilets on different vehicles, such as for ship or for mobile home. The black water must be pumped many times from one tank into the other. The aim of the system is to reuse the same waste-water following its treatment many times for the flushing of toilets. The size of the toilet tank is not enlarged, and it is not combined with clean water.

The greywater reusing systems as per the US 5,406,657 and US 5,243,719 patent descriptions describe a piping connected to the sink-hole of the wash basin or of the shower, which conducts the greywater through separate tanks to the toilet flushing tank. Besides the flushing tank, it uses one or more separate greywater tanks. The size of the toilet tank is not enlarged, and it is not combined with clean water.

The US 5,341,529 patent script for reusing greywater for flushing toilets, without enlarging the size of the "primary" flushing tank of the traditional flushing toilet, is applying a separate "auxiliary tank", which is located right above the primary tank. The primary flushing tank is using clean water, too, for flushing. The greywater is sent to the auxiliary tank by a water pump. The use of clean and greywater is already combined, but in two separate tanks.

The subject of the CA 2,093,247 patent description is a technical solution which is a combined giant flushing toilet tank reusing greywater, into which the greywater is flowing by gravitation free-fall from an upper dwelling floor. If the water in the tank is not enough for one flushing, the invention, besides reusing greywater, uses clean water as well for flushing. However, the clean water fill valve is located in a distance from the bottom of the tank which is the maximum level for clean water, measuring the volume of water enough for one flushing. This means, that if the greywater level is even slightly over the one-flush volume level, which is generally the case, the clean-water fill valve is practically always submerged in waste-water. In case of a failure of the clean-water fill valve the waste-water can infiltrate into the clean-water supply piping, since the water pressure in a completely filled up tank can be higher than the water pressure inside the clean-water supply pipe. Due to the above, this solution can not be considered hygienic. Furthermore, the tank is conceived to use greywater outside the household, originating from other neighbouring households, which may raise concern, since the user is not likely to readily receive into her/his home the waste-water of other households. The utilization of the tank takes into account only the greywater originating from washing oneself, which accounts for about 30% of household water consumption, but it does not target use of the greywater originating from the washing machine which represents a further 20% approximately. Toilet flushing accounts about 40 % of household water consumption for.

The aim of the invention is to eliminate the disadvantages of the technical solutions known up to date, and to develop a greywater recycling system which is operating automatically, recycles the greywater from the washing machine, as well, and makes use of greywater accumulating only within the same household, furthermore, which is simple and inexpensive.

The basic idea of the invention is the recognition that the implementation of the measures described in the claim 1 will result in a system which is more advantageous than the previous ones.

The greywater recycling system, in accordance with the stipulated target, primarily for the economical flushing of toilets, consisting of one or more tanks, bath tub, a washing machine provided with a primary water pump, water supply pipe, greywater pipe, flushing conduit, flushing valve, and in the tank a floating ball, is built up in a way that the floating ball is fixed by means of a pivoted support arm to the side wall of the tank allowing it to swing in vertical plane, and an actuating shaft fixed onto the floating ball, passing through the greywater column above the floating ball is connected to the clean water fill valve of the water supply pipe.

It may be typical that the washing machine being connected to the bath tub with a greywater suction pipe is provided with a secondary water pump, which, in turn, is connected to the tank by means of a secondary greywater drain pipe. There is an in-line water sensing unit mounted before the secondary water pump enabling it to start automatically, and after the drain orifice a non-return valve is mounted into the secondary greywater drain pipe.

In one version of the invention, there is a stopping member fixed to the side wall of the tank, determining the position of the floating ball closing the clean water fill valve as well as the ratio of greywater and clean supply water. The primary water pump is connected to the tank by means of the primary greywater drain pipe, which is also provided with a non-return valve.

In further possible versions the greywater tube is connected with a greywater valve to the primary greywater drain pipe, and in given cases to the secondary greywater drain pipe. On the outlet of the greywater pipe there are one or more filtering units suitably mounted within the tank. The tank has a compensating air orifice for the compensation of the atmospheric pressure. The tank is provided with an overflow tube, the diameter of which is greater than or equal to that of the greywater pipe.

The greywater recycling system as per the present invention has numerous advantages. Its operation is fully automatic, thus needs no human intervention whatsoever. In case the large combined tank is overfilled, the greywater surplus flows automatically to the

toilet bowl through the overflow tube. Inasmuch as there is not enough greywater for one flushing, the system provides fresh water supply automatically. It is operating with pumps as well, therefore it is not absolutely necessary to found its operation on gravity free-flow due to dwelling floor differences, and it is using only the grey-water originating within one and the same household. The water pumps are located in as safe place inside the washing machine, thus no additional power supply is needed. The system is simple to install, and its manufacturing is economical, since it consists of parts the majority of which is well-known.

In the following, the invention is presented in detail with examples of technical solutions on basis of drawings. The attached drawings present the following:
Figure 1 shows the longitudinal section of the tank,
Figure 2 shows a possible version of the system.

Figure 1 shows the 1 tank, the 2 greywater valve, the 3 water supply pipe, the 4 fill valve, the 5 shut-off valve, the 6 floating ball, the 7 flushing valve, the 8 flushing conduit, the 9 overflow orifice, the 10 overflow tube, the 13 filtering units, the 14 disinfecting unit, the 15 actuating shaft, the 16 pivoted support arm, the 17 compensating air orifice, the 18 stopping member, and the 19 greywater pipe.

The 1 tank can have various dimension, the 100 litre size is advantageous. The greywater arriving through the 19 greywater tube is directed through the 13 filtering unit, consisting of a metal pre-filter screen and a finer filter. This filters out possible pieces of hair, and threads or fluffs. The 14 disinfecting unit chlorinates the greywater. The treated greywater flows into the 1 tank. Inasmuch as the water quantity exceeds the capacity of the 1 tank, the 11 greywater surplus flows through the 9 overflow orifice and the 10 overflow tube and exits the tank through the 8 flushing conduit. The diameter of the 10 overflow tube is identical to or greater than that of the 19 greywater tube. When flushing, by opening the 7 flushing valve the quantity of water necessary for the flushing – about 6 - 7 litres – is leaving the tank through the 7 flushing valve and the 8 flushing conduit. The 11 greywater can mix with the 12 supply water. If there is a

sufficient quantity of 11 greywater present the location of the 6 floating ball is fixed at the 20 supply water level.

The 6 floating ball comes into action when the 1 tank does not contain 11 greywater, or the water quantity in the 1 tank sinks below the level of about 6 - 7 litres determined by the 18 stopping member. In such a case, the 16 pivoted support arm swings downward, the 15 actuating shaft on its turn opens the 4 fill valve. Fresh 12 supply water flows into the 1 tank through the 3 water supply pipe and the 4 fill valve. The inflowing 12 supply water pushes the 6 floating valve upwards, also moving upwards the 15 actuating shaft, which closes the 4 fill valve. At that moment, the 6 floating ball is at the 20 supply water level. If after that 11 greywater flows into the tank, the 6 floating ball can no more rise upwards, because it bumps into the 18 stopping member, so it remains at the 20 supply water level.

Limiting the upward movement of the 6 floating ball is also possible at the articulating joint where the 16 pivoted support arm is fixed to the 1 tank. In this way, the 12 supply water can flow into the 1 tank only when the water quantity in the 1 tank is below the volume sufficient for one flushing. In the 1 tank the atmospheric pressure and the steady flowing out of the flushing volume is ensured by the 17 compensating air orifice.

Figure 2 shows the 1 tanks, the 21 primary water pump, the 22 bath tub, the 23 supply pipe connection, the 24 solenoid valve, the 25 water supply connection, the 26 outflow orifice, the 27 primary greywater drain pipe, the 28 washing space connecting duct, the 29 washing space connection, the 30 washing machine, the 35 secondary greywater drain pipe, the 36 water sensor, the 37 washing space and the 38 non-return valve. Figure 2 shows two pieces of 1 tank, but the number of tanks can be one or more. In case of one tank, the 27 primary greywater drain pipe and the 35 secondary greywater drain pipe can be connected.

The 21 primary water pump is the original water pump of the 30 washing machine. It is required that the power and the lifting height of the 21 primary water pump is increases to exceed those of the pump types presently used in washing machines, in function of

the dwelling floor difference and the distance to the 1 tank. The power of the electric centrifugal pumps most widely used in washing machines is about 100 W. The increased power of the 21 primary water pump is between 100 and 400 W, preferably 200 W, its increased water pressure is between 0.4 and 1.0 bar. The 31 secondary water pump incorporated into the 30 washing machine is preferably in the upper segment of the above mentioned power range, preferably 400 W, and its water pressure is between 0.5 and 1 bar. Its power supply in ensured by the power supply of the 30 washing machine, in a way that it is working automatically, and it is completely independent of all the original functions of the 30 washing machine.

The 31 secondary water pump is activated by the 36 water sensor – that can be enabled/disabled by a separate switch – and it comes into action when water arrives and sensed in the 32 greywater suction pipe. The 36 water sensor is optimally located between the 31 secondary water pump and the 33 suction pipe connection. The 38 non-return valves prevent backflow of the greywater. The greywater from the 30 washing machine is pumped through the 29 washing space connection, the 28 washing space connecting duct, the 21 primary water pump, the 26 outflow orifice, the 38 non-return valve and the 27 primary greywater drain pipe to the 1 tank. The water supply of the 30 washing machine is also indicated, through the 23 supply pipe connection, the 25 water supply connection, and the 24 solenoid valve. The greywater from the 22 bath tub is drained through the 32 greywater suction pipe, the 33 suction pipe connection, the 36 water sensor, the 34 drain orifice, the 38 non-return valve and the 35 secondary greywater drain pipe into the 1 tank.

Under the protection of the patent other versions of the present system are also possible. As an example, the 7 flushing valve can be mounted on the 8 flushing conduit in the W.C. on a different floor, and not on the lower part of the 1 tank which 1 tank may be located in the attic. The greywater recycling system of the present invention provides the solution primarily for the automatic recycling of greywater originating in the households from washing machine and the bath tub by reusing the greywater for flushing the toilet.